

BLIP Raster Review

LASER BEAM-PROFILE MONITOR

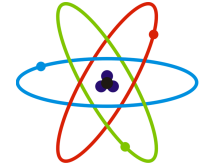
Roger Connolly

September 12-13, 2013



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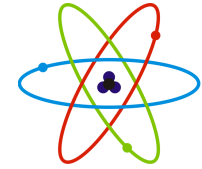
Outline of talk



- Laser profile measurement
- Beamline location
- System diagram
- HEBT LPM
- Operation
- Cost and FTEs
- Relevant development work 2014
- Risks
- Summary



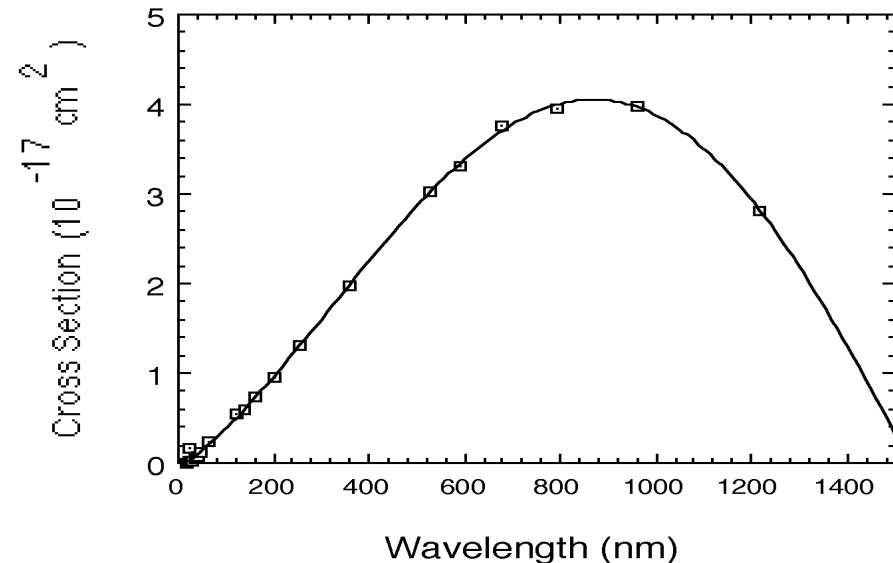
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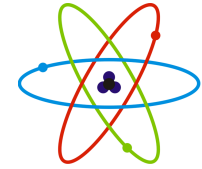


Beam profiles measured by laser stripping

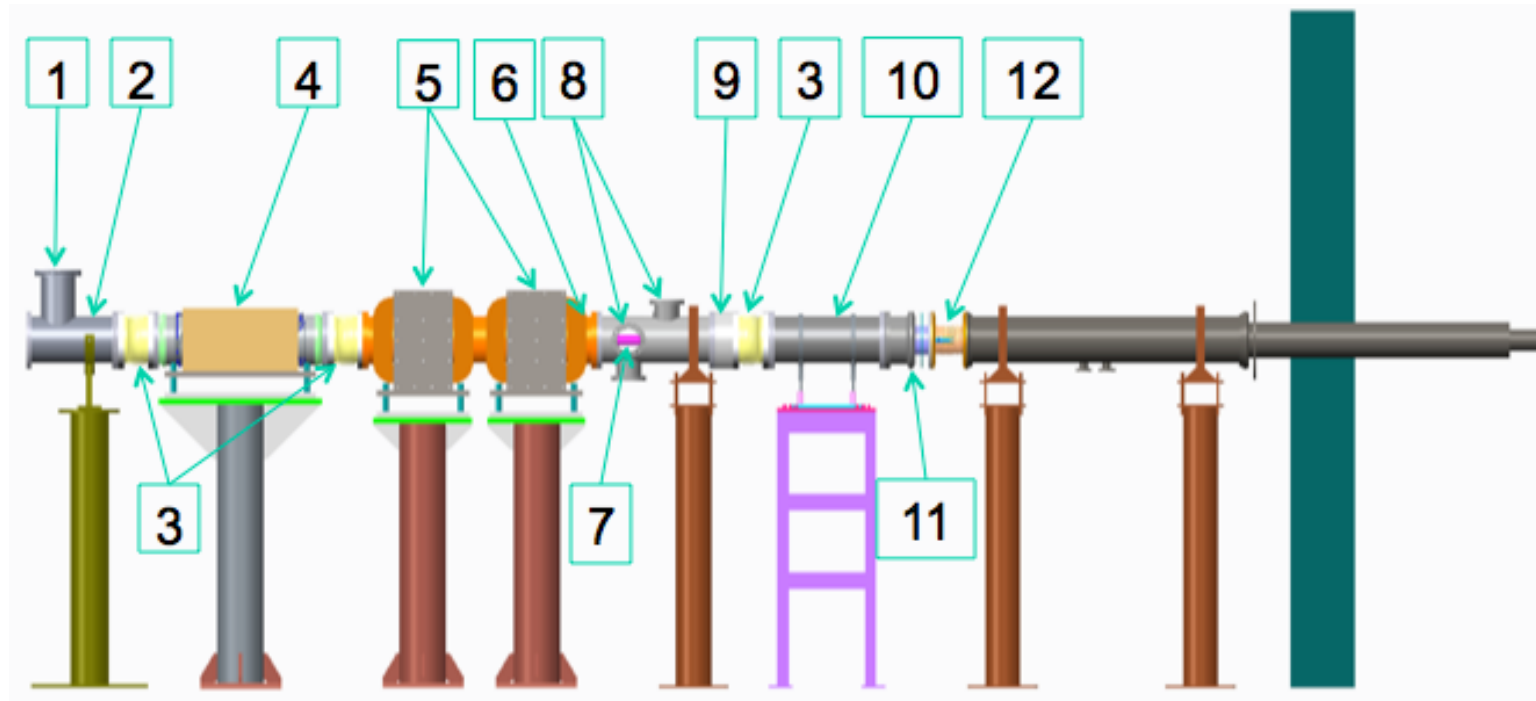
- Electrons are stripped from the H⁻ beam by a laser beam and deflected by a dipole magnet into a Faraday cup.
- Profiles are produced by moving laser beam across the ion beam and measuring laser-produced electron pulse.
- Measurement of H⁻ beams by laser neutralization is a proven technique developed at Los Alamos.
- Beam profile measurements were developed at BNL and used successfully at BNL, Fermilab and SNS.

The cross section for electron removal is peaked at wavelengths of about 1000nm. In this part of the spectrum there are many industrial lasers.





Beamline location

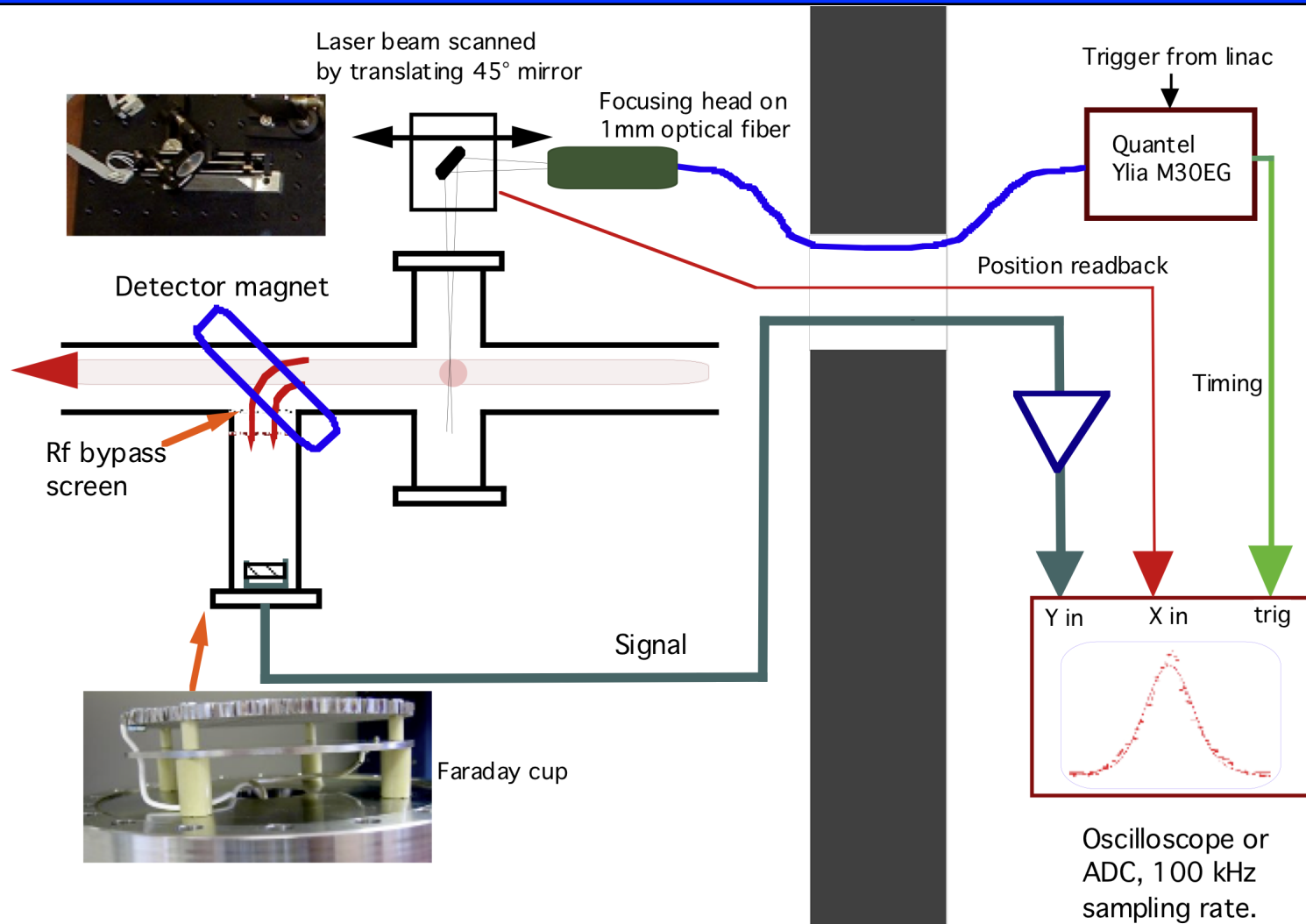
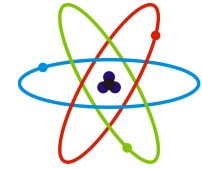


1. plunging harp
2. 6.50" collimator
3. bellows (3x)
4. raster magnet
5. steering magnets (existing, 2x)
6. 4.00" collimator

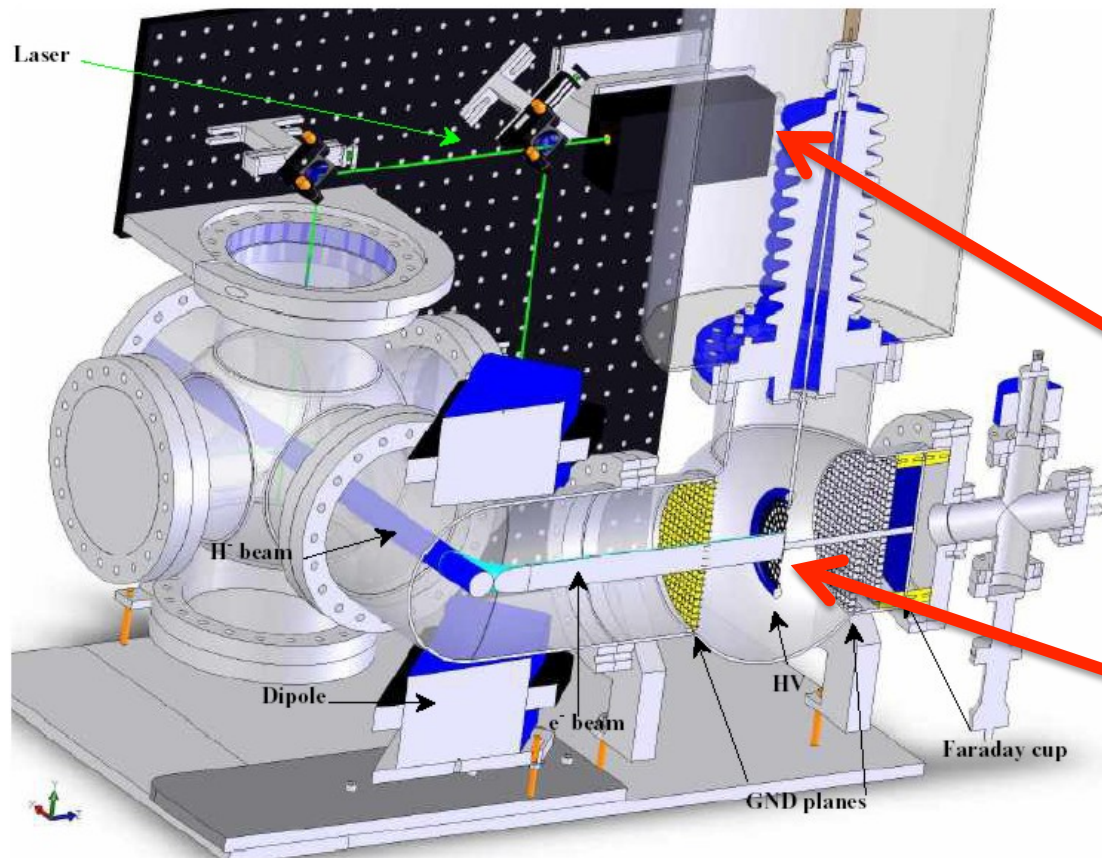
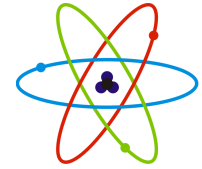
7. plunging harp (opposite side)
8. laser profile monitor
9. beam current transformers (2x)
10. beam position monitor
11. beryllium window (existing)
12. aluminum bellows (existing)



Block diagram of system



Design will be copy of the linac HEBT LPM

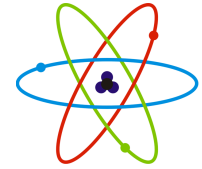


This is the detector installed in the HEBT after DTL,9. The BLIP LPM will have two differences:

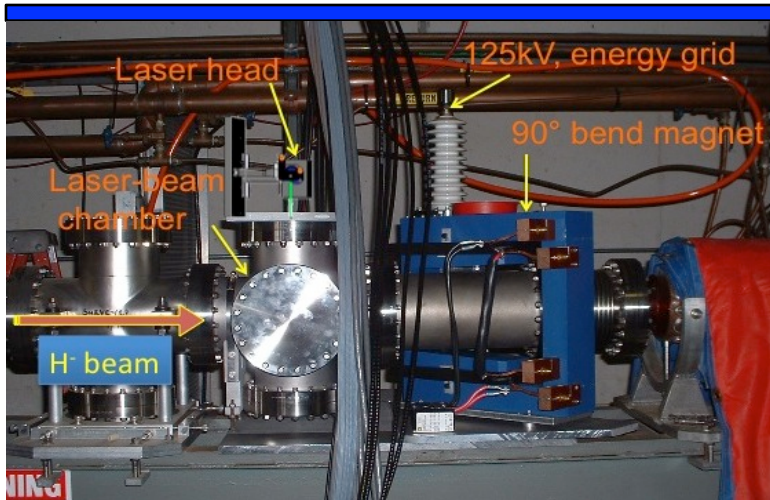
Laser head will not be on optics plate. Light will be brought into the tunnel on optical fiber.

There will be no energy analysis of the signal electrons.

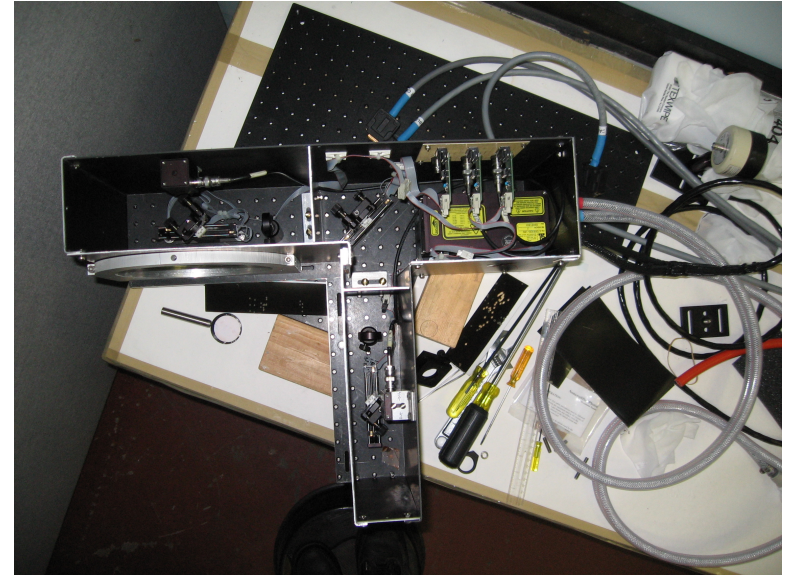




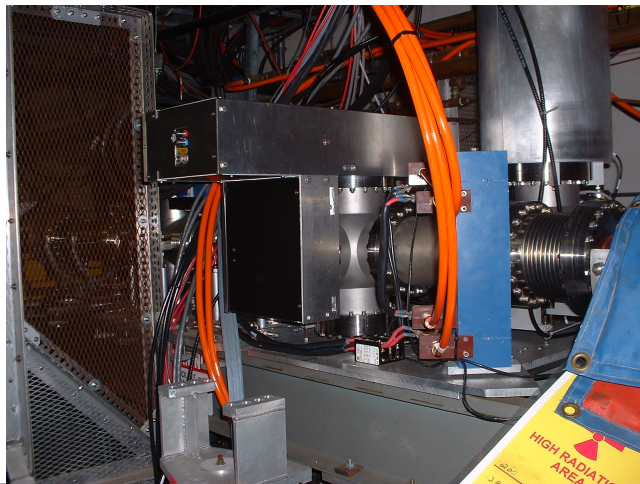
Photos of the HEBT LPM



Tunnel installation without optics plate



Optics plate



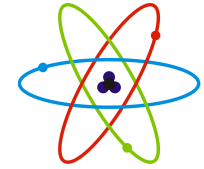
The BLIP installation will be similar,

Laser head out of tunnel, with optical fiber
No energy measurement



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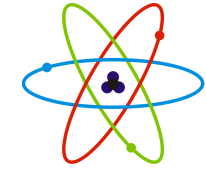
Operation



- The fiber laser produces 100ns light pulses 10-50 μ s apart. During one 400 μ s linac cycle we will digitize 8-40 electron signal pulses.
- To construct the average beam profile we will sum all of these pulses for each laser position.
- Beam raster at 5kHz executes two revolutions during single measurement. To confirm rastering we will look for modulation of the electron signal during a single linac cycle.
- Average profile is built up from 50-100 linac pulses.
- One plane is measured at a time. Raster modulation appears in both vertical and horizontal measurements.



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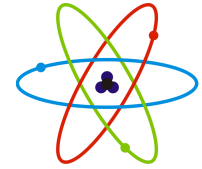


Cost and FTEs

WBS	Task Name	Hours	FTE's	\$k		
				Cost	Contingency	Cost + Contingency
1.2.1.3	Laser Beam Profile Monitor	2,228	1.3	420	123	543
1.2.1.3.1	Design First Quarter	338		48	14	63
1.2.1.3.2	Design Second Quarter	570		81	24	106
1.2.1.3.4	Procurement	112		126	38	164
1.2.1.3.5	Fabrication	312		43	13	56
1.2.1.3.6	Assembly & Test	716		97	29	126
1.2.1.3.7	LabView Programming	120		16	5	20
1.2.1.3.9	Documentation	120		8	0	8

Resource Category	Estimated Hours	FTEs
Designer	112	
Engineer	1,016	
I.T. Professional	640	
Scientist	60	
Technician	400	
Subtotal	2,228	1.3
Trades		
Central Shops		
Subtotal	0	0.0
Total	2,228	1.3





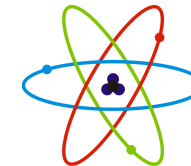
Relevant development work, 2014

- Transportation of light into the tunnel on optical fiber will be tested on the new HEBT LPM this run.
- We have bench tested the YLIA M20EG fiber laser. The M30EG should be optically the same with 50% more signal.
- Quantel will provide a fiber coupling from their YLIA M30EG fiber laser.
- With preliminary funding we can test the fiber laser at the HEBT installation in Run 15.
- This HEBT installation will use 45° parabolic mirrors this run. If these are successful we will use the same optics for BLIP.

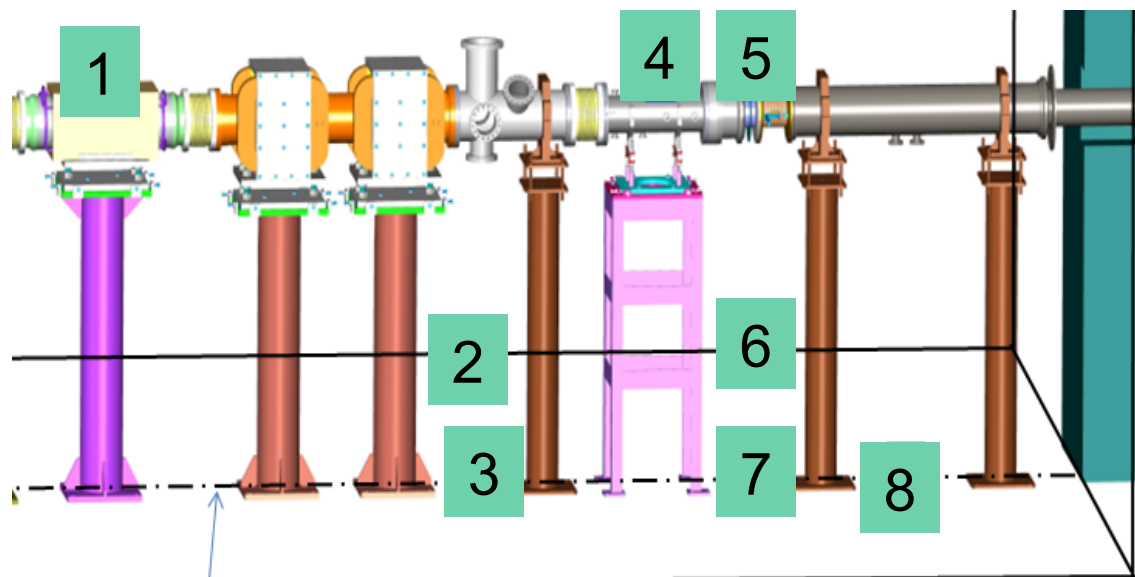
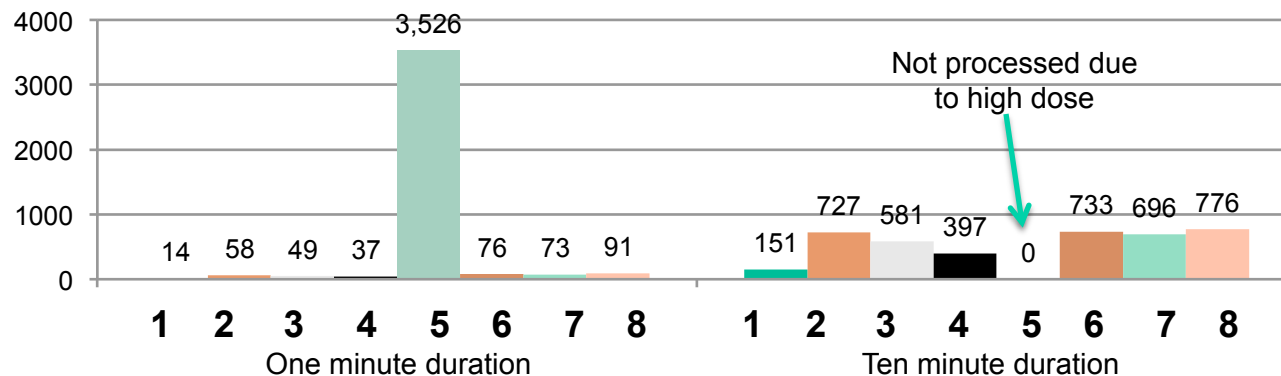


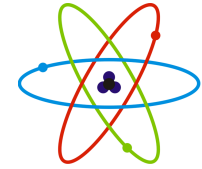
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TLD Readings in the BLIP Spur During Operations



8814 Neutron + Gamma Dose (Rem)



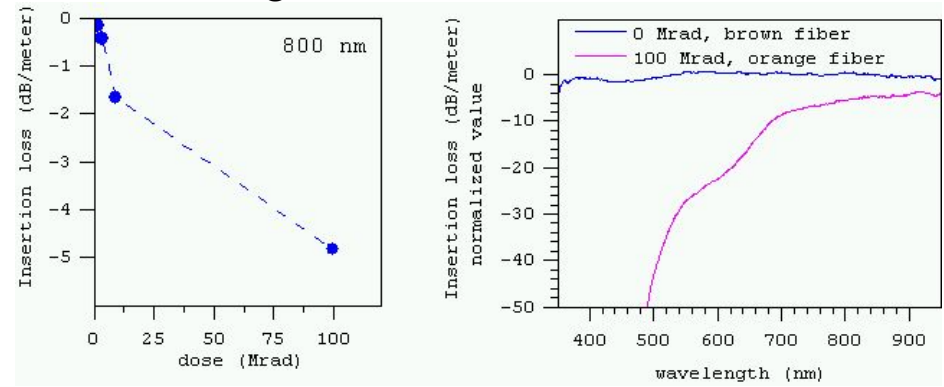


Risks

Darkening of fiber:

This effect is much smaller at 1060nm wavelength than in visible

From the dosimetry data on the last slide we estimate the radiation dose rate at the LPM to be 2550 rad/hour. 100Mrad will be achieved after 1633days or 4.5 years of continuous running.



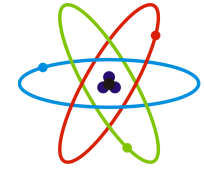
The glass fiber will be replaced as required.

Co-60 source on Corning Infinicar fibers (non-rad-hard fiber).

Radiation damage to linear actuators used to translate laser optics. The NAI actuators currently used show no damage after one year in the HEBT however there are circuit boards in the tunnel for terminating the long drive lines. During the 2015 beam run we can test several translation stages in the BLIP tunnel.



Summary



- Measurement of H^- beams by laser neutralization is a proven technique used at BNL, LANL, Fermilab and SNS.
- The device proposed here will be a close copy of the HEBT LPM which was installed in 2010. The design of the BLIP LPM will benefit from the HEBT experience.
- We propose purchasing a QuanteL M30EG laser during the next year and installing it in the HEBT LPM for testing during the 2015 beam run.
- We propose testing several translation stages in the BLIP environment during the 2015 beam run.



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